SOME CORDILLERAN PLANT SPECIES NEW FOR THE SIERRA NEVADA OF CALIFORNIA

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In any floristic study, two aspects of the flora can be the center of interest: 1, local endemism; 2, phytogeographical relationships to other regions. This paper is concerned with the second, i.e., with some taxa found in Convict Creek basin on the east slope of the Sierra Nevada, having a unique ecological setting, and disjunct from the Rocky Mountains, the eastern Great Basin ranges, or the Cascades. The basin contains at least five geographically disjunct plants, namely *Arctostaphylos uva-ursi*,[1] hitherto unreported for the Sierra Nevada, and *Kobresia myosuroides* (Vill.) Fiori & Paol., *Scirpus pumilus* Vahl, *Salix brachycarpa* Nutt., and *Draba nivalis* Liljebl. var. *elongata* Wats. new for California. The disjunct presence of *Pedicularis crenulata* at the mouth of Convict Canyon has been known for some time (Munz, 1959).

On the advice of G. L. Stebbins we selected the Convict Creek Basin as a starting point for our studies of Sierra Nevada alpine plant ecology. We spent 9–12 June, 6–13 July, and 12–31 August, 1962 in the basin. This paper is a first report on our findings.

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ECOLOGICAL UNIQUENESS OF THE CONVICT CREEK BASIN

Most of the high Sierra Nevada is a monotonous expanse of glaciated, gray granodiorite. It does have enclaves of metamorphic rocks, and Convict Creek basin and the Mount Baldwin area is one of the most interesting of these and is ecologically unique in several ways. A half mile wide strip of coarse-grained, gray marble extends north from Mount Baldwin in the southeast corner of the basin past Laurel Mountain on the north rim.

Convict Creek basin is on the desert side of the Sierra Nevada just south of Mammoth Mountain, between Leevining and Bishop. Figure 1

[1] Nomenclature corresponds to Munz (1959) except where an author is named.

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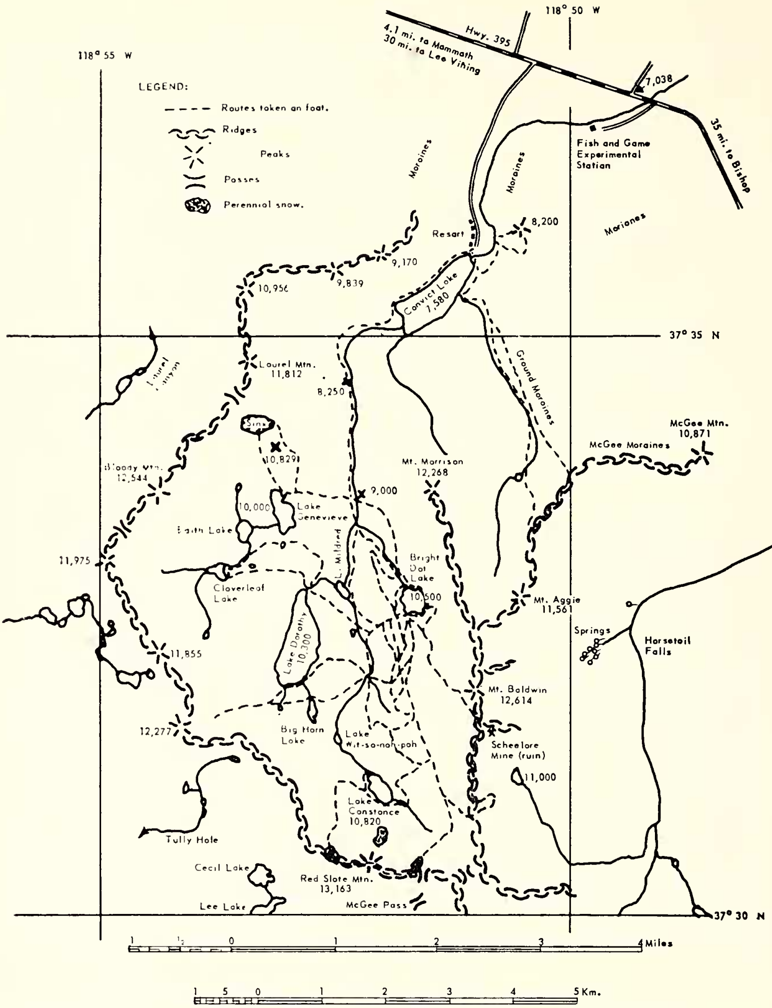

Fig. 1. Map of the Convict Creek basin, Sierra Nevada. From the U. S. Geological Survey topographic map of the Mount Morrison quadrangle, published 1953, 1/62500, 80 ft contour interval.

shows salient features and our routes of travel. A geographical discussion of the area with photographs of the lakes is contained in Reimers, Maciolek, and Pister's bulletin (1955).

Convict Lake, dammed by terminal moraines at the mouth of Convict Creek, is at an elevation of 7580 ft. Cirque floors in the upper part of the basin contain lakes and generally lie at elevations of 10000 to 10800 ft. The highest elevation on the rim of the basin is Red Slate Mountain at 13163 ft. Quite extensive remnants of old, subdued surfaces exist above 12000 ft.

Geologically the area is very complex. Most of the surface of the basin is underlain by dark red, metamorphic hornfels, marble, and vari-colored sandstones. The northwest corner of the basin is the usual granodiorite. Faulting has been extensive. The geology was mapped and discussed by Mayo (1934), and more detailed information for field use was obtained through the courtesy of D. C. Ross of the U. S. Geological Survey.

The basin is not extensively forested, for glaciation has removed soil from much of the area, and slopes are so steep that much of the winter's snow avalanches. Detritus from the easily weathered bedrock forms extensive scree slopes where bedrock itself is not exposed. Rock glaciers are common from the outcrops of more resistant rocks. Much of the basin is above the low forest limit at about 10600 ft. Timberline Krummholz (*Pinus albicaulis*) is about 1200 ft higher on the granodiorite.

Of the ecological factors commonly considered as influencing where plants occur (Major, 1951), the Convict Creek basin differs little or not at all from most of the rest of the Sierra Nevada at comparable altitudes in climate, relief, grazing and fire history, lengths of time available for plant succession, or available fauna and flora—although the last factor evidently deserves more attention than it has yet received. The basin basically differs from most of the Sierra Nevada in its large area underlain by calcareous soil parent materials. Some 1371 acres are underlain directly by the Mount Baldwin marble. An additional 114 acres is underlain by marshy, meadow sediments predominantly derived from the marble. In addition, the widespread hornfels has calcareous lenses, and dust accumulated on the snow in winter is calcareous.

These calcareous substrates immediately affect plants. The mountain climate in this basin is insufficiently moist to produce acid humus layers over the calcareous parent material, and thus offer possibilities for an acidiphile regional climax vegetation to form the zonal plant cover as in Braun-Blanquet and Jenny's (1926) classic case from the Swiss Alps. We should note here that Ellenberg (1953) disputes Braun-Blanquet and Jenny's conclusion that the climax Caricetum curvulae forms on strictly calcareous rock. He believed from experience in the eastern Alps of Austria that admixture of siliceous rock to the calcareous parent material was necessary. We could find no evidence that an acidiphile climax vegetation would form on the marble of the Convict Creek basin. However, the Sierra Nevada ecosystem differs so much from that of the Alps in other respects—notably in climate and flora—that comparisons are difficult.

Associated with the calcareous bedrock are general aridity and contrasting, local, and contiguous areas continuously wet from seepage water. These continuously wet seepage areas can also be well-drained.

Convict Creek basin in general is strikingly less lush than Dana Meadows or upper Rock Creek basin located a few miles north and south, both of which are in relatively impermeable granodioritic basins. The Convict Creek basin itself probably receives as much precipitation as other east-side canyons, but it disposes of it differently. Much water percolates directly through fault-shattered bedrock, and especially through solution channels in the marble, into underground channels beyond the reach of plant roots. Convict Creek as a matter of fact is doubled in size by a large spring at the 8250 ft level; other small springs are common on the cliffs; and in McGee Creek immediately to the south the springs at Horsetail Falls are notable (fig. 1). A deep topographic sink in shattered hornfels and marble just south of Laurel Mountain does not hold pemanent water in spite of the great quantities of snow which are blown into it.

Not only is water lost by underground seepage, to be concentrated and regulated in flow in springs or seeps, but the marble weathers into a very coarse soil with very low field capacity. Some such "sand flats" of comminuted calcareous rock forming only an incipient soil may appear almost devoid of plants. The impression of aridity on other vegetated, flat areas is extreme. The presence of extensive steppe plant communities at 10100 to 10700 ft lacking annual plants, of widely-spaced bunch-grass physiognomy, with much bare soil surfaces, and consisting of such species as *Stipa comata, Oryzopsis hymenoides, Chrysothamnus nauseosus, Artemisia tridentata, Lygodesmia spinosa, Brickellia oblongifolia* var. *linifolia,* and *Muhlenbergia asperifolia* (in warm seeps), does nothing to lessen that impression. Such areas form an extreme contrast both physiognomically and ecologically with the adjacent, lush, green, bright-flowered areas of cold-water seepage where numerous rare and disjunct boreal plants occur.

An Ecological Note on Floristics and Taxonomy

We shall discuss the geographical distribution of the disjunct taxa, with notes on their ecology. The best extant guide to their ecology is their geographical distribution. The guide becomes more precise the more precisely the distribution can be described. The only definitive statement on plant distribution is a dot map. This is true both for rare and for common plants. Obviously coalescence of dots is a function both of rarity, map scale, and frequency of collection. Our effort here is to provide some background for dot maps of the species discussed. We welcome more information. Because none of the literature statements on the geographical distribution of the disjunct plants mentioned is as accurate as possible, we have attempted to modernize such statements. Our debt to Hultén's Alaska flora (1941–1950) is obvious, but by using subsequently published local floras even his descriptions can be improved. A further reason for elaborating on the geographical distribution of our species is that the botanical literature mentions these plants and describes their distribution repeatedly. The described distributions all differ. Thus, the literature is a source of confusion and not of help. It is desirable to try to bring some order into this uncorrelated confusion.

Disjunction of Arctostaphylos uva-ursi

This species is widespread in the northern hemisphere, being circumpolar, boreal, and montane to the south. Meusel (1943) described it as amphiboreal montane-continental, and grouped it with plants of similar chorology such as *Allium schoenoprasm* L., *Goodyera repens* (L.) R. Br., *Populus tremula* L.—*P. tremuloides, Chimaphila umbellata, Pyrola secunda, P. uniflora* L., and *Linnaea borealis.*

In North America *A. uva-ursi* is found in continental western Greenland and from Newfoundland to southern Hudson Bay, southern Keewatin, over Great Bear Lake, to Alaska and south in the mountains to Virginia and to northern Indiana and Illinois, Missouri, northern Minnesota, North and South Dakota (Black Hills) and south in the western Cordillera to New Mexico, Arizona, Nevada, Oregon, and coastal northern California. In northern Eurasia it is found from Iceland and northern Scandinavia across the continent to Okhotsk and Sakhalin south of the treeless arctic for the most part, and south to Ireland and northern England, the coniferous forest region of central Europe, in the mountains of northern Portugal (Hegi, 1927) and southern Spain, eastern France, the central Appenines, Albania, Macedonia, and Bulgaria, in the Himalayas and Altai (Hegi, 1927), the Caucasus, across northern Russia south to the Voronezh region and eastwards across the Urals, and scattered in Siberia in the coniferous forest belt south to Lake Baikal (Hultén, 1941–1950) plus other pertinent floras). Lipschitz (1961) has described the Caucasus plant as a new species, *A. caucasica* Lipsch., and believes it is a Tertiary relict in the flora of the Caucasus. More details on the Eurasian distribution of *A. uva-ursi* are available in Hegi (1927) and in Kirchner, Loew, and Schröter (1923).

Arctostaphylos uva-ursi in California is scattered down the coast to Point Reyes north of San Francisco Bay, is on San Bruno Mountain south of the Bay (Munz, 1959) and has recently been reported even further south at Point Sur in Monterey County (Roof, 1961). It is not on calcareous substrates in these sites.

Many of the California coastal specimens are aberrant morphologically, even for such a variable taxon as *A. uva-ursi.* They do not all appear to be the Rocky Mountain form whereas the plants in the Convict Creek basin are. Lenz in working on this problem at the Rancho Santa Ana Botanic Garden.

Specimens from mountain elevations (5665 ft) in Humboldt County (*Kildale 10660,* DS) and under *Pinus ponderosa* in eastern Del Norte County (*Applegate 5248,* DS) seem to be the widespread *A. nevadensis* of the Sierra Nevada, the Coast Ranges, the Cascades, and the Blue Mountains.

Arctostaphylos uva-ursi is common in the Rocky Mountains and also just across the Great Basin, occurring in the Wasatch Mountains of Utah and the Ruby Mountains of Nevada (Holmgren, 1942) over 250 mi to the northeast of the Sierra Nevada stations. It is not in the Toiyabe

Mountains (Linsdale, Howell, and Linsdale, 1952) halfway to the Rubies nor in the Deep Creek Mountains between the Rubies and the Wasatch (McMillan, 1948). As a mountain plant Merkle (1951) lists it for Mary's Peak in the Oregon Coast Ranges, but Baker (1956) did not record it from Iron Mountain in the Rogue River Range some 130 mi to the south although some of its normal associates are found there. It does occur northeast and west of Klamath Lake in southern Oregon under lodgepole pine only a little distance north of the California state line (*Applegate 3770,* DS). To the southwest from Convict Creek, Kearney and Peebles (1951) doubted its reported occurrence in Arizona. However, it was collected by E. K. Douglas in 1934 at 9000 ft in Tsailee Canyon, Navajo County (UNM). The species is scattered in the mountains of northern New Mexico not only along the southern extensions of the Colorado Rockies east and west of the Rio Grande River south to Santa Fe but also near the Arizona border in the northwestern corner of New Mexico (Wooton and Standley, 1915).

This is the most widespread of the "new" plants in Convict Creek basin (*Major & Bamberg 851, 856, 865, 933, 990,* DAV). It occupies the widest range of altitudes and ecological conditions. It occurs as low as 8250 ft at the stream crossing in Convict Creek canyon under blond *Betula occidentalis* and with such plants as *Equisetum laevigatum, Sphenosciadium capitellatum, Habenaria hyperborea, H. dilatata* var. *leucostachys, Carex hassei, Sisyrinchium halophilum, Solidago multiradiata, Castilleja miniata,* and *Taraxacum officinale.* It is in seepage areas at 10000 ft or so on more or less physically disintegrated marble with *Kobresia myosuroides, Potentilla fruticosa, Carex pseudoscirpoidea, Salix orestera, S. brachycarpa, Thalictrum alpinum, Botrychium simplex, Trisetum spicatum, Solidago multiradiata, Castilleja miniata,* and *Epilobium latifolium.* It is quite common in almost pure mats on both marble and hornfels in seepage areas of cliffs. It is on the ledges of steep cliffs where snow accumulates under either *Pinus flexilis* or *P. albicaulis* and on hornfels knobs along the shore of Bright Dot Lake where snow is probably blown off in winter. It even occurs on marble scree just below Lake Mildred.

Disjunction of Kobresia myosuroides

This is another circumpolar species classed by Meusel (1943) as amphiarctic-alpine-continental with plants of similar chorology such as *Carex rupestris* Bell. ex All. (including *C. drummondiana* Dewey), *C. atrofusca* Schkuhr (lacking in the North American mountains), *Draba fladnizensis, Saxifraga cernua* L., *S. hirculus* L., *Sibbaldia procumbens, Potentilla fruticosa,* and *Sedum rosea.* Meusel's distribution map can be corrected and expanded in America using Porsild's (1957) and other floras for other regions. In the New World *K. myosuroides* extends from Greenland west through Labrador and arctic and subarctic Canada to Great Bear Lake and Alaska. It occurs through the Canadian Rockies with considerable gaps as known at present to northern New Mexico and also occurs isolated in northeastern Oregon. In Eurasia it is known from Iceland across to Kamchatka and the Chukotsk Peninsula with a gap from Scandinavia to the Taimyr Peninsula except for an occurrence in the Urals. It has southern, alpine outliers in the Pyrenees, Alps, Appenines, Balkans, Carpathians, the Asiatic mountains from Dzungaria eastwards through northern China and the mountains of southern Siberia and Mongolia to Korea and central Honshu in Japan. Closely related species occur in the Caucasus and Pamirs to the Himalaya and Tien Shan Mountains.

Kobresia myosuroides is considerably more disjunct at Convict Creek than even *Arctostaphylos uva-ursi.* It is also more limited ecologically. To the east it occurs first on the slopes of Mount Emmons in the Uinta Mountains of Utah (Graham, 1937; Hermann, 1934; Murdock, 1951) at the headwaters of the Uinta River and in adjacent areas according to Lewis. In Colorado it is abundant in the alpine tundras, and it extends south into New Mexico (Wooton and Standley, 1915). To the north of the Sierra Nevada it is recorded from alpine summits of the Wallowa Mountains in Oregon (Peck, 1961). In other words, the Sierra Nevadan stations for *K. myosuroides* are disjunct by over 500 mi from the closest stations to the east and 560 mi to the north.

Ecologically the *K. myosuroides* (*Major & Bamberg 867, 950, 952, 1297, 1376, 1464, 1472,* DAV; *1498,* COLO) occupies a more limited range of altitudes and sites in the Convict Creek basin than *Arctostaphylos uva-ursi.* It occurs from about 9700 to 10600 ft in two kinds of habitats: 1, seepage areas with or without *Arctostaphylos uva-ursi* on distintegrated marble (soil pH about 8) and with many of the plants listed under the higher altitude *Arctostaphylos uva-ursi* stands, plus *Parnassia palustris* var. *californica, Aquilegia formosa,* and *Habenaria hyperborea;* and 2, meadows with good drainage but surface still only a few decimeters above the water table, either on marl or hornfels (pH 7.5–8.0), with *Salix brachycarpa, Carex pseudoscirpoidea, Juncus balticus, Deschampsia caespitosa, Solidago multiradiata, Thalictrum alpinum, Pedicularis attolens, Gentiana holopetala,* and *Parnassia palustris* var. *californica.* Many of the plants typical for the springs and seepage areas are missing from these meadows, but the stand surveys recording both kinds of communities can probably be arranged in a floristic and therefore ecological continuum.

In general, *K. myosuroides* is known as a calcicole or a species indifferent to substratum calcareousness (Schröter, 1926). It is a calcicole in Convict Creek basin. It does occur on hornfels substrates as well as on marble. However, most areas in the basin are treated with calcareous dust blown by the wind from the extensive bare areas of marble and marble detritus and accumulated in the winter's snowfall, and so soils from hornfels adjacent to calcareous areas remain basic. On the other hand, this *Kobresia* occurs abundantly and dominantly on James Peak in Colorado on soils of pH (4.6)–5.4–5.6–(6.0) (Cox, 1933) and in the Uinta Mountains of Utah at pH 5.6–6.8 (Murdock, 1951). It is a climax dominant in the alpine tundras of the Uintas and in Colorado (*op. cit.*, Marr, 1961; Weber 1961). Thus, one would expect *K. myosuroides* to occupy the most highly developed, leached soils in a mountain climate which provides water in excess of current needs so soil leaching occurs. In the Alps for example the subclimax *Kobresia* (as the Elynetum) occupies soils of pH 6(5–7) developed over limestone, but it is replaced by the climax Curvuletum on more acid, more highly developed soils (Braun-Blanquet and Jenny, 1926). Regionally, zonal alpine tundra soils in Colorado dominated by *K. myosuroides* are (Retzer, 1956) uniformly acid except where derived from limestone. Acidities may be as strong as pH 4.5 although most are in the range of pH 5–6. It is possible that *K. myosuroides* has one range of edaphic demands in northern Eurasia and the Sierra Nevada and another in the southern Rocky Mountains and the Alps, but competition could equally well explain the apparently anomalous tolerances.

Disjunction of Scirpus pumilus

Only a single station for this diminutive plant (*Major 1298,* DAV) was found in the Convict Creek basin. This species is disjunct from Colorado on the east or from Montana to the northeast and is circumboreal in distribution although rare everywhere and widely disjunct in its other North American and Eurasiatic stations. Its ecology is enigmatic. Raymond (1957), Hylander (1945), and Hultén (1958) have discussed the taxonomy, nomenclature, and distribution of *S. pumilus.*

Meusel (1943) classed *S. pumilus* chorologically as a plant of arctic-alpine continental distribution, specifically eurasiatic-alpine continental, along with *Anemone narcissiflora* L., *Androsace chamaejasme* Wulfen, *Gentiana algida* Pallas, and *Aster alpinus* L. The taxa selected from this chorological group of Meusel's as familiar all occur also in western North America although they are lacking in the East. Therefore they could be part of Meusel's amphiarctic-alpine continental group already mentioned under *Kobresia myosuroides,* namely those with a gap in eastern North America.

Scirpus pumilus is widespread but very scattered and usually described as rare in the Alps from the Dauphine and Cottian Alps to Savoy, the high Valais, eastern Graubunden to the upper Adige and on the Eisack (Isarco) near Brixen (Bressanone) in the South Tyrol in moist, calcareous, often open sites. Localities (Hegi, 1939) in the Tessin are mentioned which more or less connect the eastern and western groups of stations in Switzerland. The many stations enumerated by Braun-Blanquet and Rübel (1932–1936) would make a small continuous area in southeastern Graubunden on the small scale of Hultén's map. A still more eastern station, unmentioned in the floras available to us, is mapped in eastern Austria. This may be the unmapped station at Delnice just east of Fiume in Jugoslavia mentioned by Hermann (1956). *Scirpus pumilus* is on boggy, calcareous soils in the northern Carpathians of Slovakia (Raymond, 1957). Five stations are now known from northernmost Norway (Nordhagen, 1963). Only on a large scale map can these be differentiated from the two stations mapped. In Norway the plant occurs locally in wet sites both at sea level and near the birch altitudinal limit on dolomite and also on the boundary between the subalpine and low alpine regions on calcareous schist (Nordhagen 1963). The plant is rare in alpine bogs in the western Caucasus to southern Ossetia (Grossgeim, 1949). Boissier (1881) long ago recorded the plant from the high Persian Mountains, and both Raymond and Hultén add stations. From as far south as 30°N latitude the plant's area is more or less continuous, although actually stations are widely scattered within it, into Afghanistan, the Karakorum, and western Tibet. A combination of the two maps would give a somewhat altered picture of distribution in the western Himalayas. Very isolated occurrences are shown in the trans-Volga lowland, in the southernmost Urals, and farther north along the Tobol River. Kotov's (1943) double station near Ufa on meadow solonchak soils of the floodplain of the Dema River in Bashkiria is not shown on either map. It may be the mentioned trans-Volga station misplaced. The same, or perhaps another station, is mentioned by Hermann (1956) at Chkalov (Orenburg) on the Ural River south of Ufa. Other lowland stations also occur along the Irtysh River near Omsk and northeastward, west of Tomsk. These lowland stations must be in the saline meadows referred to in Soviet floras. The dot shown on both maps on the Syr Darya River some 200 km east of the Aral Sea is not mentioned in the floras of the USSR or Kazakhstan. It is improbable in this desert, but then many of the stations recorded in southern Siberia would seem inhospitable to a high altitude or boreal plant. Stations are missing from the maps according to the flora of Kazakhstan (Pavlov, 1958) in the forest-steppe of the Kokchetavski district and to the southwest in the presently internally drained Turgai steppe district where runoff from continental glaciation once passed. The Zaisan and Altai districts are correctly shown as having the plant, but to the southwest the Dzungarian Alatau should have it also. The western and central Tian Shan have the plant; the area northwest of Chimkent along the upper Syr Darya should also, as Raymond's map does although his dots extend far into the Kyzl Kum desert. Here again the two maps need to be reconciled. To the southwest of the Tien Shan the area should be more or less continuous, on the map scales used, in the Pamirs and Hindu Kush. In Tadzhikistan an irregular area between 40–37°N and 67½–74½°E has 43 stations listed (Ovchinnikov, 1963). The stations are actually scattered, occurring in an ecologically wide variety of sites from 1800 to 4200 m elevation. From the Altai both maps have the area extending north along the upper Ob River. The adjacent Angara-Sayan area has the plant in several places. On the south side of the Mongolian Altai the plant occurs at Uinchi (46°N, 92°E) in the foothills and in the sink of the Bodonchi River where the water vanishes in the desert (Egorova, 1959). In Mongolia the plant is described by Grubov (1955) as very rare, occurring in the Kahangai forest steppe, far to the east in the Mongolian steppe, and adjoining the more or less continuous area toward Lake Baikal (Popov, 1957). The area extends north of Lake Baikal, southeast toward eastern Mongolia, and into the Chahar province of China. An isolated station in northern Szechuan is kept as *spp. distigmaticus* Kük.

In North America at the mouth of the Gulf of St. Lawrence the stations on the Mingan and Anticosti Islands are well-known (Raymond, 1957). They are on calcareous substrates. In western Canada are stations in Alberta in calcareous bogs (Moss, 1959). The stations in the vicinity of Banff, all at valley elevations of 4600 to 5000 ft, have been known for some time. A new one is Porsild's (1959) in a fen on calcareous clay to the north near Jasper along with about a dozen of our Convict Creek basin plants. Fernald (1931) listed our plant for two British Columbia stations, one of which is actually in Alberta. The plant does occur in British Columbia but not near Banff, evidently (Hultén, 1958). Porsild and Crum (1961) describe the first record for British Columbia at Liard Hot Springs where it is "very local in wet calcareous mud." Except for the maritime Norwegian stations, this station is the farthest north. The plant occurs in western Montana in meadows (Booth, 1950). There is a disjunct plains station in an alkaline bog just east of Saskatoon in Saskatchewan (Fraser *et al.*, 1954) which is very reminiscent of many of the Siberian stations north of the high mountains. The widely disjunct station in Colorado is a good one according to Weber (1961a) even if the plant has been found only once. Our station in California is not that mentioned by Abrams (1923).

The California disjunction of *S. pumilus* is very large—about 750 mi to the single Colorado locality or to those in western Montana. It is surpassed however by the Norwegian disjunction.

In the Convict Creek basin *S. pumilus* occurs in some seepage areas or wet meadows at 10200 to 10600 ft elevation with *Kobresia myosuroides, Thalictrum alpinum, Carex pseudoscirpoidea, Epilobium latifolium, Salix brachycarpa, Pedicularis attollens, Habenaria hyperborea, Danthonia intermedia, Parnassia palustris* var *californica, Carex hassei,* and *Aquilegia formosa*. These two kinds of permanently wet areas were described in discussing the ecology of *Kobresia myosuroides*.

There is universal agreement that *S. pumilus* is everywhere a hygrophilous calcicole. The combination in many very continental areas leads to describing the plant's habitat as saline meadows. This tiny plant, which is always rare, scattered, and never abundant, combines in a most peculiar way on alpine or boreal distribution and association with boreal or even arctic-alpine plants with occurrence in lowland, steppe habitats.

Ecological segregation between *S. clementis* and *S. pumilus* is as sharp in the Convict Creek Basin as that between *S. caespitosus* L. and *S. pumilus* is elsewhere. The former is restricted to subirrigated meadows or bogs on granitic alluvium or peat and the latter to subirrigated meadows or bogs on calcareous alluvium. *Scirpus caespitosus* var. *delicatulus* Fern. (Fernald, 1950) of "Calcareous gravels, shores and cliffs" may perhaps be interpreted as a form occupying an azonal habitat where competition with zonal plants is weakened on a unique soil parent material (Gankin and Major, 1963).

Disjunction of Salix brachycarpa

Salix brachycarpa is a cordilleran and boreal American willow related to the circumpolar, arctic-montane *S. glauca* L. and its associated complex. The systematics of this group is not a subject of universal agreement. We have relied mostly on the geographical, taxonomic, and nomenclatural treatments in Raup (1959), Hultén (1941–1950), Argus (1957), and Fernald (1950). Other floras have been consulted when pertinent. Raup (1959) gives rough outline maps of the northern, American species' distributions, and these maps should adequately represent current information on geographical distribution. Ecological notes agree that all the taxa in this complex occupy moist or wet, often boggy soils. Few data on vegetation associated with these species in North America have been found and very little on soil requirements.

The distribution of *S. glauca* in Eurasia is from Iceland through the Scandinavian mountains, arctic and subarctic USSR including Novaya Zemlya, and south in the mountains including the Urals, Sayan and Altai both in the USSR and in Mongolia, the mountains around Lake Baikal and of Dahuria and Khangai in Mongolia, and farther east the Okhotsk and Zee-Bureinsk regions. In North America it occurs from arctic Alaska across to Greenland and Ungava and south in Alaska and the Rocky Mountains to Lake Athabaska in Saskatchewan and to the Waterton Lakes Park region and northern Washington and Montana (Raup, 1947). There is no agreement, however, as to the southern limit of the species. In Saskatchewan Fraser *et al.* (1954) have it only to Lake Athabaska but Raup to the southern part of the province. Moss (1959) has it in only northwestern Alberta; but Porsild (1959) says it is common near Banff. *Salix brachycarpa* extends southward from Canada to the Wenatchee Mountains of central Washington on serpentine, the Wallowa Mountains of northeastern Oregon. It is also known in Idaho from the Tetons, Bear River Range, and Sawtooth Mountains, in Wyoming in the Medicine Bows, Wind Rivers, and Gros Ventre to western Yellowstone National Park, Absarokas, and Beartooth, in Utah from two localities, and in the mountains of Colorado.

Salix brachycarpa at Convict Creek (*Major & Bamberg 894, 957, 1279, 1378,* DAV) is evidently disjunct by 560 mi from the Wallowa Mountains to the north, by 310 mi from the southern Utah station northwest of the Pink Cliffs on the south edge of the Markagunt Plateau north of Zion National Park, by 440 mi from the locality at Alta in the Wasatch Mountains east of Salt Lake, and by about 530 mi to the Idaho localities.

In Convict Creek basin *S. brachycarpa* is abundant from about 9900 to 10600 ft. It is found in summer-moist seepage areas which are well-drained and in the well-drained parts of the alluvial, marly flat above Lake Mildred. It is limited to calcareous soils. Its associates have been mentioned under the higher altitude *Arctostaphylos uva-ursi* stands and both the seepage and meadow *Kobresia myosuroides* stands.

In the Medicine Bow Mountains of Wyoming *Salix brachycarpa* was found in wind-protected parts of an alpine fellfield dominated by *Carex rupestris, Geum rossii,* and *Polygonum viviparum* (Bliss, 1956) on acid (pH 5.0) soils frequently drier than the 15 atm. percentage and developed from quartzites.

Disjunction of Draba nivalis var. elongata

In 1957 Stebbins found specimens of this variety on an ascent of Mount Baldwin and recognized it as new for the Sierran flora. With his help it was again found at several localities in the Convict Creek basin during the summer of 1962.

Draba nivalis var. *elongata* occurs northwards through Wyoming, from the isolated LaSal Mountains of southeastern Utah, from the Wasatch and Uinta Mountains of Utah north and west through the Deep Creek Mountains to the Ruby Mountains of Nevada, northwards from central Idaho, northwards from the Wallowa Mountains of Oregon and the central Cascades of Washington. The disjunction to the Convict Creek localities is thus 560 mi to the north and over 250 mi to the northeast. The disjunction to the north is identical to that of *Kobresia myosuroides* but to the northeast is equal to that of *Arctostaphylos uva-ursi.*

Ecologically this taxon occupies quite a different habitat in the Convict Creek Basin as compared with *Arctostaphylos uva-ursi* and *Kobresia myosuroides*. *Draba nivalis* var. *elongata* (*Major & Bamberg 1296, 1432,* DAV) was found at about 10300 to 10800 ft and again at 11750 ft on wet, disintegrated marble scree or in wet crevices in the marble. The sites are all on north-facing slopes, steep, and covered by snow until very late in the season. The highest site was covered by over 2 m of snow in the middle of July but was snow-free the last week in August, although at 11:30 a.m. the ground was still frozen in the shade. The associated vegetation is very open with scattered individuals of such plants as *Oxyria digyna, Crepis nana,* and *Arenaria rossii.*

Disjunction of Pedicularis crenulata

Munz (1959) described the disjunct occurrence of *Pedicularis crenulata* in the Sierra Nevada as "near streams, ca. 7000 ft, Convict Creek, Mono County; to Wyoming, Colorado." The species was collected here in 1925, 1927 and 1933 by Peirson (JEPS) and recently studied by Sprague (1962) in regard to pollination. Her reported station having

"25–30 white-flowering plants" appeared to us to be a common kind of mountain meadow along the outlet of Convict Lake and 500 ft higher in elevation than Peirson's earlier stream-side collections. All these meadows are grazed by the local pack stock and have been heavily cattle-grazed. They have more the aspect of mountain meadows in the Great Basin or Rockies than of the Sierra. We could not find the plant in 1962, but there is no reason to believe it does not still occupy the area.

The distribution of *P. crenulata* is not precisely known. Tidestrom (1925), Rydberg (1922), and Sprague (1962) list it for Nevada. It was collected at Duck Creek at 7300 ft in the Schell Creek Range near Ely, Nevada (*Jones,* June 30, 1893, JEPS). It occurs in Wyoming and Colorado to New Mexico. Harrington (1954) listed it from the western half of Colorado at 7000 to 9500 ft. It extends at least from the Gunnison River southeast into the Sangre de Cristo Range to the headwaters of the Pecos River, north into the Elk Mountains, east to the Pike's Peak region, and northeast to the Continental Divide, thence north along the ranges bordering the divide and in the Park Range, into Wyoming in the Medicine Bow Mountains and along the upper tributaries of the North Platte River, and against along the upper Green River at Sublette and Daniel, on the Black's Fork of the Green River at Fort Bridger, and in Yellowstone National Park in Montana. Its area evidently does not include the Tetons and Jackson Hole (Shaw, 1958; Reed, 1952). It seems to be disjunct in the Sierra Nevada by 250 mi from the Nevada locality, disjunct in Nevada by 280 mi from the lower Green River station or 370 mi from the nearest of the numerous central Colorado stations, disjunct in New Mexico by up to 90 mi from the southern Colorado stations, disjunct along the lower Green River by 160 mi and along the upper Green River by 220 mi from the southern Wyoming stations, and disjunct in Yellowstone National Park by 130 mi from the upper Green River. Possibly a more complete herbarium and field search would fill in some of these gaps.

Could it be a recent introduction in some of these places, and specifically at Convict Creek? The note by Coulter and Nelson (1909) might suggest this: ". . . in grassy mountain meadows; spreading rapidly in irrigated meadows and becoming a pest." Or this behavior may have simply reflected the response *in situ* of an unpalatable plant to current, turn of the century abuse of the vegetation by overgrazing of domestic livestock. Its persistence and considerable area of occupancy at Convict Creek does not suggest a recently adventive plant. And there is at Convict Creek "a remarkable correlation between pollinator and flower . . . in the parallel size and curvature of the head and thorax of *Bombus fervidus* and that of the galea of *P. crenulata*. They more obviously complement each other in these respects than do any other observed species of *Pedicularis* and their pollinators" (Sprague, 1962). This correlation does not suggest an adventive plant even though this *Bombus* does not extend to the Rocky Mountains.

The habitat of *P. crenulata* is low-altitude, subirrigated mountain meadows bordered by willows and aspens. *Deschampsia caespitosa* is a common associate, with *Carex* spp., *Rosa* spp., and *Smilacina stellata* under the shrubs. The bordering xeric, well drained community may have *Artemisia tridentata,* and *Elymus cinereus.*

Discussion

The Convict Creek basin is both ecologically and floristically unique in the Sierra Nevada. Fortunately it adjoins quite typical Sierra Nevada vegetation on granitic substrates in the same drainage basin. This juxtaposition will allow contiguous comparisons to be made between the unique and the usual Sierra Nevada plant communities and their ecology. Perhaps the local uniqueness will allow correlation with other western North American mountain vegetation. This western mountain vegetation forms a unit whose geographically separated parts will be understood only in relation to the whole. Vegetation studies, including their ecological relationships, will enlighten floristic, including historical, relationships and vice versa.

While the Convict Creek basin is ecologically unique, it should be mentioned that the ecologically unique substrate to be found in the area, namely marble and its mechanically weathered products, is not the only substrate on which the floristically unique plants are found. All the six taxa mentioned occur on soils derived both from calcareous parent materials and also from noncalcareous metamorphics. It is true that none of their stations are on granodiorite, and that Convict Creek hornfels soils are often calcareous because of snowpack accumulation of windblown calcareous dust. But we are very poorly informed on the chemistry of formation of Sierra Nevadan soils on granodiorite (pedocals form on granodiorite in many climates), and other areas of calcareous metamorphic rocks exist in the Sierra Nevada yet none have been reported to harbor these six taxa. There is no one-to-one correspondence here between edaphic specialization and a floristic distinctiveness.

This last conclusion is bolstered by the extra-Sierra Nevadan edaphic behavior of these six taxa. Judging from the ecological literature, all the six disjunct taxa are indifferent outside the Sierra Nevada so far as calcicoly is concerned. Unfortunately, herbarium labels are usually deficient in such data, floras often ignore the problem, and insufficient systematic ecological and descriptive vegetation work has been done.

The six disjunct plants discussed above form a kind of equiformal progressive area in Hultén's sense (1937). They are North American cordilleran plants with boreal and arctic, and hence circumpolar, affinities. Because most are so wide ranging, they cannot be easily ascribed to any known or hypothesized centers of dispersal or persistence. And Hultén specifically excluded from his discussion species such as *Pedicularis crenulata,* known only from south of the ice of continental Pleistocene glaciation. Therefore we prefer not to discuss Hultén's actual disposition of these species. He looked on them from the viewpoint of the boreal, circumpolar biota. Our center of focus must be the cordilleran flora. This flora obviously cannot be divorced from its boreal and arctic, circumpolar affinnities, but it has recruited many members from adjacent lowland floras.

The meaning of the equiformity and progessiveness of distributional areas exhibited by our six species must be left to further, systematic floristic studies, but it is difficult to believe that we have here either a simple coincidence of distributional areas or a distribution pattern based solely on ecological demands of the six species concerned.

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NATURAL AND ARTIFICIAL HYBRIDS OF BESSEYA AND SYNTHYRIS (SCROPHULARIACEAE)

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Within the Scrophulariaceae is a group of five genera well set apart from others in the family (Pennell, 1933). All are characterized by basal, petiolate leaves, scapose inflorescences, and weakly zygomorphic (veronica-like) flowers. Two of the genera, *Synthyris* and *Besseya* occur in western North America, from sea-level to timberline. Species of *Synthyris* are either woodland inhabitants or occur as elements of the snow-flush flora of high montane slopes. *Besseya* species are less mesic in habitat; the most common species, *B. rubra,* occurs in open yellow-pine forests or the bunch grass-forb-shrub vegetation type.

The intriguing distribution of species in *Besseya* and *Synthyris* as well as in their Eurasian relatives has prompted a long-range study of the clan. Morphological, cytological, and breeding criteria will be sought to determine the relationships of the highly disjunctively distributed species.

NATURAL HYBRIDS

Early in the study it was called to our attention that *B. rubra* (Dougl.) Rydb. and *S. missurica* (Raf.) Penn. underwent sporadic hybridization in the Clearwater River drainage of west central Idaho. The first collections of the hybrid were made by Fred Warren, a student of Harold St. John at Washington State College. Living plants of this initial collection are still growing in Carl English's garden in Seattle and have been examined by the authors.

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